

and the bicycle ergometer. Also we feel that the very slow rise in oxygen consumption seen during the first six minutes of both STEEP tests make them an unsatisfactory basis for the extrapolation of maximal oxygen uptake from maximal workload and for measuring the subtle changes observed after a given treatment. Before being tested in patients, these new protocols should be extensively tested in healthy volunteers and compared with other exercise protocols.

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This letter was shown to the authors, who reply as follows:

SIR,—The data presented by Dr Essamri and colleagues in 13 male volunteers confirm many of our findings with the STEEP exercise test. There are, however, some important differences that may be explained, at least in part, by methodological considerations. It is

likely that young men living in Belgium are more accustomed to cycling than our Glaswegian volunteers and this may explain why they are able to perform more aerobic work on a bicycle ergometer. Furthermore, the significance levels quoted were obtained using unpaired *t* tests, such that for the final stages the six fittest subjects who were able to complete the bicycle protocol were compared with the whole group who completed the treadmill protocol. It is not surprising that the six fittest subjects had a higher mean oxygen consumption than the group as a whole. It would be more appropriate to use a paired test, such that data from subjects completing a given stage of one protocol are compared only with data from the same subjects during the other protocol.

We are encouraged that Dr Essamri and colleagues agree with the need for standardisation of exercise testing within Europe—but which protocol are we to use as a standard? The STEEP protocol has several advantages over existing protocols, including short stages (as recommended by Buchfuhrer *et al*<sup>1</sup>), suitability for both treadmill and bicycle testing, adjustment for body weight during

the bicycle protocol so that subjects of different size exercise at similar relative intensity at each stage, and exponential increments in workload making the test applicable to a very wide range of patients. None of these improvements over existing protocols is contested in the letter from Essamri *et al*. They have, however, demonstrated a difference in oxygen consumption during the later stages of the treadmill and bicycle protocols, which may indicate a need for a minor modification of one or other protocol. However, we did not suggest that the two tests were identical, only that they were comparable. Bicycle and treadmill testing have certain fundamental differences—which were discussed in our original report. The STEEP tests merely offer a pragmatic solution to the problem of standardisation when some laboratories use treadmills while others use bicycle ergometers.

Their assertion that the final workload increments are too large in heavy subjects is clearly unwarranted because the whole point of adjustment for body weight is that all subjects experience the same relative workloads and increments. In fact the data of Essamri *et al* confirm this principle because the standard deviations of the mean oxygen consumption for each stage of the bicycle protocol (assuming that their figure shows standard deviations rather than standard errors) are very small even though the study included a remarkable range of body weights—from 62 kg to 115 kg. We fully agree that the STEEP protocol is not suitable for inferring maximal oxygen uptake from maximal workload in patients with cardiovascular disease—but this is not recommended for any protocol.<sup>2,3</sup>

Finally, we think that firm conclusions cannot be reached until new standard exercise protocols, such as the STEEP test, are validated in suitable patient populations.

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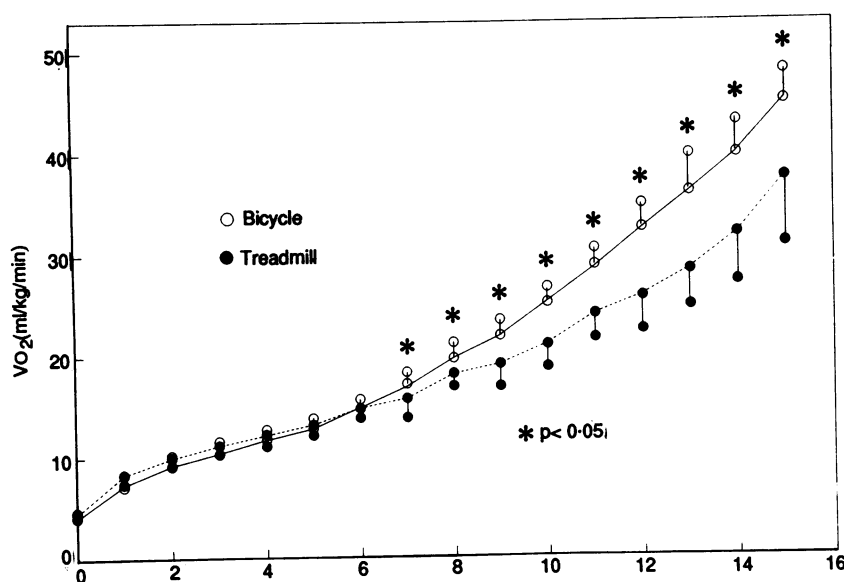


Figure 1 Oxygen consumption.

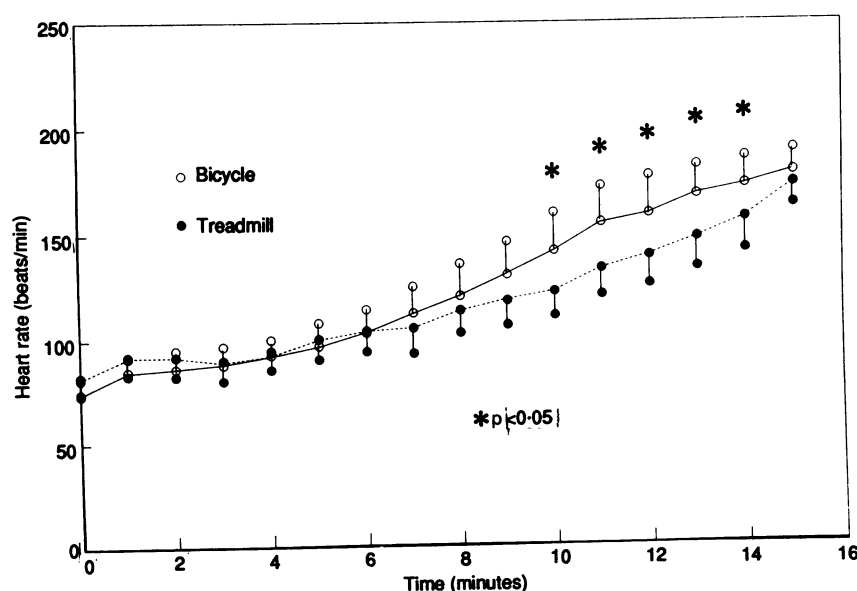


Figure 2 Heart rate.

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- 2 Ragg KE, Murray TF, Karbonit LM, Jump DA. Errors in predicting functional capacity from a treadmill exercise stress test. *Am Heart J* 1980;100:581-3.
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#### Fatal aortic rupture during balloon dilatation of recoarctation

SIR,—I read the paper by Balaji (*British Heart Journal* 1991;65:100-1) with interest. They reported aortic rupture and death in an eight year old child after balloon angioplasty for aortic recoarctation that developed after patch angioplasty procedure. We have had extensive experience with balloon angioplasty of aortic coarctations, both native and postoperative,<sup>1-9</sup> and have not observed a similar complication. We do not agree with Balaji *et al* that balloon angioplasty should be avoided in cases of recoarctations after patch angioplasty. The complication reported in Balaji *et al* is a problem related to the technique of angioplasty that they adopted.

Firstly, I do not believe that balloon angioplasty should be performed without monitoring the pressure in the balloon. The purpose of monitoring the pressure is not to prevent

overinflation (as they seem to imply) but to prevent rupture of the balloon. I believe that balloon rupture should be prevented at all cost, not only to avoid complications such as that reported by Balaji, but also to prevent arterial injury, which is more likely during the removal of a ruptured balloon.

Second, I do not understand the purpose of attempting to redilate with a 12 mm balloon after a previous dilatation with a 15 mm balloon.

Third, the Olbert catheter system that Balaji *et al* used in this case produces longitudinal movement of the balloon material over the internal surface of the aorta and is likely to injure the aorta further.

Based on our experience<sup>1-9</sup> and that reported by Cooper *et al*<sup>10</sup> and Hellenbrand *et al*<sup>11</sup> we believe that aortic recoarctations that develop after all types of coarctation surgery—namely, end-to-end anastomosis after resection, subclavian flap angioplasty, patch angioplasty (Dacron, Gore-Tex, or pericardial patch), and interrupted aortic arch repair—can be successfully dilated.

To prevent aortic rupture and/or subsequent aneurysms it is vital to avoid manipulation of the tips of the guide wire and catheters in the region of freshly dilated coarctation and to avoid using a balloon that is larger than the descending aortic diameter at the level of the diaphragm.

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This letter was shown to the authors, who reply as follows:

SIR,—We thank Dr Rao for his helpful comments. However, we do not agree with some of them. Dr Rao has reported seven cases of angioplasty for recoarctation<sup>7</sup> without giving any patient details, particularly about the nature of their previous surgery. All the other reports<sup>1-9</sup> from his group deal with native coarctation in 30 cases, a lesion in which the method of action of balloon angioplasty may be very different to that in recoarctation.

The results of Cooper *et al*<sup>10</sup> that Dr Rao quotes to support his conclusions come from our hospital. Until the aortic rupture that we reported,<sup>1</sup> our experience with angioplasty for recoarctation was very promising indeed. Our chief aim in drawing attention to this case was to introduce a note of caution. As we indicated in the case report, there are few reported cases of angioplasty in patients who have previously undergone patch aortoplasty. Most workers including Dr Rao have not reported details of the previous surgery that the patients had undergone. We cited, however, the large and successful experience from the Boston group in patients who had had patch repair.

We accept we should avoid balloon rupture and now suggest pressure monitoring of the balloon is used. We chose to use the smaller Olbert balloon because we believed that it was firmer than the larger Meditech balloon, which had had no "apparent" effect on the coarctation.

In our experience longitudinal balloon movement is equally likely with all balloon catheters. Perhaps what is more important is the straightening effect of the balloon within a curved structure such as the aorta. It is our long-standing practice not to manipulate guide wires or catheter tips across freshly dilated coarctations.

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- 11 Hellenbrand WE, Allen HD, Golinko RJ, Hagler DJ, Lutin W, Kan J. Balloon angioplasty for aortic recoarctation: results of Valvuloplasty and Angioplasty of Congenital Anomalies Registry. *Am J Cardiol* 1990;65:793-7.

## BOOK REVIEW

**Principles and practice of cardiovascular imaging.** Edited by G M Pohost and R A O'Rourke. (Pp 942; £115.) Boston, Toronto, London: Little, Brown & Company, 1991. ISBN 0-316-71247-7.

The practice of modern cardiology requires extensive use of imaging. The everyday value of echocardiography and angiography in routine diagnosis has made the cardiologist a provider as well as a user of imaging. Though many present day cardiologists have contributed to the development of new imaging techniques it is still difficult to keep up to date with all aspects of imaging and to be sure of its rational use. Trainee cardiologists have an even more difficult task because they need to understand the principles and practice of a wide range of imaging techniques, all of which have an extensive literature. This book, in drawing together under one cover all the common methods used, including the uses of echocardiography, radionuclides, x ray, and magnetic resonance imaging, brings partial salvation.

The book is organised into three sections: the first deals with the technology of each imaging method, the second with the clinical applications, and the third with cost considerations. The first and largest section is the most rewarding, with the basic principles of physics, safety, and protection preceding the clinical use of each technique. Despite the multi-author approach each section is balanced, and the writing is clear and crisp and extensively referenced—though there is a tendency to ignore work published in non-

American journals. No doubt for cost reasons the colour plates are aggregated together at page 749 but this is not clearly signalled in the section on colour flow Doppler mapping (pp 136-145). It seems a pity that the colour plates were not incorporated into this chapter.

I had looked forward to reading the second section which sets out to show how the technologies should be used to solve common clinical problems rather than what they can do. I found this section disappointing, however. Again it tended to show what could be done rather than what was needed to make the diagnosis. Separate chapters that cover echocardiography and radionuclides in the investigation of cardiac muscle disease without bringing in the possible use of magnetic resonance imaging illustrate a divided rather than an integrated approach. The style of this section is also more uneven, with some authors taking a more clinical approach than others. The illustrative cases in the section on valvular heart disease by Kotlewski and Rahimtoola seem to have caught the spirit of the section better than others. In all, the section seems better in conception than in execution.

National Health Service funding for imaging equipment has always been difficult but cost considerations are becoming increasingly important. We are still some way removed from a prospective payment system based on diagnostic-related groups (DRGs) but medicine does seem to be marching in this direction. The final section of the book gives an excellent account of the North American experience and tackles important issues such as the impact of imaging on the health care system and the implications for the future. This section is mandatory reading for anyone managing imaging services.

Despite reservations about the middle section this book is a valuable guide to the use of imaging. It should be read by all trainees and referred to frequently by all users and providers of cardiac imaging services.

ALEXANDER L MUIR

The title reviewed here is available from the BMJ Bookshop, PO Box 295, London WC1H 9TE. Prices include postage in the UK and for members of the British Forces Overseas, but overseas customers should add 15% to the value of the order for postage and packing. Payment can be made by cheque in sterling drawn on a UK bank, or by credit card (MasterCard, VISA, or American Express) stating card number, expiry date, and your full name.

## NOTICES

1992

The Annual Meeting of the **British Cardiac Society** will take place at the Harrogate International Centre on 26 to 29 May. The closing date for receipt of abstracts will be 3 January.

The 3rd International Conference on **Cardiac Doppler-Echo and Color Flow Imaging** will be held in Dubrovnik on 31 May to 3 June: ICCD, Dr Nikša Drinković, Department of Cardiovascular Diseases, University Hospital Centre Rebro, Kišpatičeva 12, 41000 Zagreb, Yugoslavia (Fax: 41 420-793. Tel: 041/434-444, 435-555).